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Kateryna Andriushchenko,
Andrii Buriachenko,
Anastasiia Liezina,
Oksana Lavruk,
Nataliia Korzhenivska,
Nataliia Slavina

THE IMPACT OF LABOR RESOURCES ON THE ECONOMIC SECURITY OF AN ENTERPRISE IN THE SUSTAINABLE DEVELOPMENT CONCEPT

The functioning and development of enterprises largely depends on economic security, which consists of many functional components. The object of the study is the personnel security of the enterprise, and the paper itself is focused on identifying its factors that determine the level of labor safety. Analysis and assessment should become an important component of developing a labor safety strategy in the context of sustainable development. Currently, there are various methods that allow analyzing labor resources and their condition, but their use does not always make it possible to determine the level of sufficiency of characteristics; uncertainty arises that prevents a more objective assessment of situations. The study shows the problems of personnel security, considers and analyzes its components, and proposes an analysis method based on the fuzzy set method, which allows calculating the impact of each component with a greater degree of reliability. Using the fuzzy set method, an assessment of the personnel security of Joint Stock Company "National Nuclear Energy Generating Company "Energoatom" (JSC NNEGC Energoatom, Kyiv, Ukraine) for five years (2018–2022) was carried out, which made it possible to conduct a more objective analysis. Qualitative assessment of the impact of such indicators as average wages; frequency of injuries; level of saturation with specialists; level of professional training of employees; average age of employees; the share of young specialists is given. Starting from 2020, as the analysis showed, there has been a decrease in the level of personnel security indicator. The reason for the decrease in the level of personnel security of the enterprise was the decrease in the level of specialists in the total number of employees, especially young specialists, as well as the deterioration of the dynamics of employee training. The paper proposes measures to increase the level of personnel security of JSC NNEGC Energoatom.

Keywords: *economic security, enterprise, personnel, labor resources, sustainable development, fuzzy set method.*

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1. Introduction

In a society with growing consumption, the problems of ensuring the economic security of various levels of organizations and systems began to be thought about relatively recently, and at the same time, these issues are familiar to researchers and direct participants in economic processes. The importance of economic security of any organization in dynamically developing economic relations can hardly be overestimated, but a systematic solution to this problem remains a difficult result to achieve. The tasks solved in this article are the tasks of ensuring the economic security of the organization and increasing its efficiency through systematic personnel management and improving personnel policy using.

Coverage of this issue is quite relevant given the fact that world statistics show that 80 % of material losses to enterprises are caused by their personnel [1]. From 2011 to 2024, the number of crimes as a result of personnel actions reached 73 %. In Ukraine, the level of corporate fraud is higher than the indicators of developed countries and is approximately 13 %. At the same time, disproportions in measures to prevent corporate fraud are also observed.

With a low level of motivation, there are chances of dismissal, destructive influences of the external environment, etc. Therefore, personnel may resort to shady schemes of earning income even more actively. These may include stealing company property, inciting strikes, causing damage in the form of stealing property. At the same time, personnel can be defined as the most important resource and the bearer of opportunities for maintaining at the proper level all components of the economic security of the enterprise, ensuring its stability and competitiveness. That is why 93 % of the leaders of the world's leading companies noted the need for changes in personnel policy as a basis for supporting personnel security [2].

The search for solutions to the problems of preventing economic crime and offenses by personnel simultaneously

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leads to other urgent tasks. These include increasing professionalism, maintaining intellectual capital, and protecting against external competition. All this necessitates a deep and systematic definition of the essence of personnel security, its content, main components, and the connections between them.

The specifics of the enterprise's activities determine the specifics of its work. This especially affects the concept of ensuring the economic security of personnel. Because the specifics of the work determine the results and the prospects for planning the qualitative and quantitative composition of the team. Naturally, such an approach is only possible if there is a clear development strategy, a formulated mission and operational goals.

When determining economic security, one should proceed from the main goal of the organization's functioning. As is known, the goal of the economic and financial activity of the enterprise in the conditions of the market economy is the maximization of profit and its rational use, which is explained by the very nature of entrepreneurial activity.

Having analyzed the various approaches of scientists, it is worth noting the broader and global context of the study of economic security. According to [3], economic security affects relationships at the global level, and at the same time, global changes very closely affect the formation of economic security from the micro-level of the enterprise to international relations.

In this direction, the works [4, 5] also deserve attention. Each of the scientists adds to the opinion that the economic security of the enterprise is its ability (possibility) to earn profit stably and to use it effectively in the conditions of numerous influences of external and internal factors. Also in this direction, scientists of [6] support the opinion that economic security in the concept of ensuring sustainable development should be based on the growth of labor resources and increasing the potential of employees of enterprises due to development small and medium-sized businesses relying on foreign investments. Also in this direction, the scientist of [7] adheres to the opinion that economic security in the concept of ensuring sustainable development should be based on the growth of labor resources and increasing the potential of employees of enterprises [8]. Its opinion is to eliminate poverty and spread the welfare of the population through the creation of appropriate working conditions and career growth. Research in various countries of the world regarding economic security and its components, namely card potential, is confirmed by the works [9, 10] – analysis and development of China's economic security, [11] – criteria for the improvement and development of Sicily, [12] – in which the authors emphasize the subjects of economic analysis security and their information accuracy in the USA.

As is known, the components of economic security of enterprises are:

- financial;
- technical and technological;
- informational;
- political and legal;
- personnel (labor).

Based on these components, let's consider the personnel component of economic security to be one of the essential ones. This opinion is confirmed in the works [13–15], who believe that in modern conditions, the economic security of an organization depends on the joint influence of many factors, both external and internal, on its economic and financial activities. At the same time, it is difficult to say with some certainty which of these factors are more important.

Thus, in the works [16, 17] our attention is drawn to the strong emphasis on workers from the point of view of strengthening economic security. This is primarily due to the fact that personnel security is a component of an integral system of economic security. At the same time, let's believe that the term "personnel security" should be understood as the totality of manifestations of all labor resources of the enterprise's employees. In this case, all of them purposefully apply their intellectual, creative, personal and other abilities in order to fully fulfill their duties. And also, within the framework of their pipe activities do not cause harm to the employer and other colleagues. In this case, personnel security directly affects the processes of ensuring and strengthening the economic security of the enterprise. In our opinion, this manifests itself through the elimination of risks and threats associated with the use of labor. And the work of the entire team forms the potential for strengthening the enterprise's activities and its sustainable development.

In the paper [18], considerable attention is paid to the training of future employees and to the general improvement of the classical approach to universities. The authors are of the opinion that today's archaic practices no longer work in the modern world, so it is worth moving in step with the times and forming updated knowledge for personnel. In this case, it is possible to observe the formation of new skills and competencies among future employees, the identification of motivational factors to obtain the maximum result, and the enrichment of the knowledge component [19]. But at the same time, it is not possible to expect a quick result in the implementation of this generation in work. It should take a minimum of time to acquire knowledge and apply it in practice. That is why we are impressed by the authors of the work [20], who consider modern education and educational institutions as business accelerators, for which it is inherent to implement joint learning and exchange of experience between students and teachers. That is, for the development of personnel potential, which will form in the future an updated approach to the performance of one's duties, this is a significant step forward, but strengthening the economic security of the enterprise in this case can be considered only for future sustainable development.

Further analysis of the scientific literature confirms the pluralism of approaches and the lack of objectivity in some aspects regarding the methodological basis for determining economic security and its components. Thus, in the work [21] prove that the growth of quantitative indicators of the volume of products produced is not a criterion for the economic security of the enterprises of the industry chosen for analysis. And the dynamics of absolute and relative financial indicators on average in the industry indicates the insufficiency of resources for the implementation of the entire production process. In this case, the author proposes to implement management solutions based on the optimization model of the transition from an unsatisfactory balance sheet structure to a satisfactory one. In our opinion, this approach is quite subjective and depends on the subject of evaluation. In this case, the direct influence of the personnel of the enterprise on the process of formation of economic security, which is impossible without its provision, is again traced. This point of view is also supported by the authors of the work [22].

There is a wide variety of methods and ways of determining the level of economic security. However, in the process of analysis, it is important to take into account the industry characteristics of the analyzed object.

The level of personnel security, and therefore economic security in general, depends on how competently and effectively the management will be able to avoid possible threats. Therefore, in the event of their possible occurrence, the skills of the personnel must be able to quickly eliminate any consequences of certain factors [23–25]. But let's believe that the first consideration should be the aim and purpose of conducting any HR analysis. So, it is precisely the position of conducting this event, as a component of economic security, that is to identify the factors that determine the weak points of personnel security, to assess the level of its indicators that characterize it at every moment of time.

Analysis and evaluation should become an important component of both short-term and medium-term forecasting and development of the company's labor protection strategy within the framework of long-term economic development policy. Thus, according to [26], for this, the analysis of factors and indicators of the state of labor protection should be an integral part of the analytical work of creating the economic security of the enterprise based on the tools of gentrification.

It should also be noted that within the framework of our study, the energy sector was chosen, which is currently in high demand and is considered life-sustaining. In this case, after studying a number of studies, it is possible to determine the components of personnel security for the energy industry. Work [27] provides a detailed description of the impact of sustainable development of the energy industry on ecology, as well as working conditions at these enterprises. From which it is possible to conclude that labor safety is an important factor for ensuring personnel security. The study [28] examines potential damage to property of energy enterprises through terrorism and harm caused by employees due to low wages and labor motivation. Thus, an analysis of the critical infrastructure of African countries shows the importance of studying labor motivation and professional development in the framework of ensuring personnel security. Also, aspects that influence the formation of personnel security are the presence of highly qualified specialists in the industry and their level of education. Based on the study [29], in which the main issues are discussions of China in terms of ensuring energy security, let's find confirmation of this assumption.

Thus, as a result of the analysis of the latest scientific developments, we would like to combine each presented aspect and propose to consider the following components as factors determining the level of occupational safety for energy enterprises:

– the level of motivation of labor resources;
– level of labor safety;
– level of saturation of the organization with specialists;
– personnel structure, represented by the age level of employees;
– the level of professional development.

The authors of the work [30] pay great attention to the motivational component and ethical norms that regulate the processes of improving the work of employees. In the development of the components of personnel and economic security, [31] direct their work in the context of saturation of the workforce with specialists and highly qualified personnel with the help of imprinting factors, which are formed as a cultural, hereditary and national sequence to the desire to improve. This has a positive effect on increasing the level of economic profit of the enterprise, and in their work, these scientists confirm this with a systematic analysis of 19 imperial data based on imprinting factors in the study of enterprise personnel management processes. The work [32] on occupational safety and working conditions is also not left out. In their work, the authors emphasize the importance of occupational health and safety as a factor that ensures an increase in the duration of belonging to a single workplace. In this case, it is possible to agree that such components of working conditions as work schedules, protection from trade union organizations, improvement and establishment of communications in the team directly affect labor resources. And the reverse effect and deterioration can lead to a deterioration of the specified factors. This has a direct negative impact on the level of economic security of the enterprise.

The review of scientific developments proves the increased attention to the specified direction of research. The latest developments have a rather wide range of manifestations, but they are united by the existing methods of analyzing personnel potential, which, accordingly, has an impact on the economic security of the enterprise.

Among the most widespread approaches to the analysis of the level of labor safety of the enterprise, the following should be included – economic, technological, socio-psychological, administrative, disciplinary, administrative. In [33] emphasize the importance of the social-psychological method. And the authors of [34] focus on leadership qualities and emphasize administrative approaches. These and other works are based in their sequence on the fulfillment of the following conditions:

– the analysis process should use data for a long period of time;
– reporting data of the enterprise must have a high level of sufficiency, reliability, objectivity and comparability;
– for the analysis, it is expedient to use only those indicators that can really characterize labor safety;
– the analyst conducting the analysis must possess a sufficient set of economic indicators for the analyzed enterprise.

Accordingly, let's consider it relevant and necessary to study in detail the personnel potential of an energy enterprise, to establish the relationship of all its constituent factors. As already indicated above – this is the level of motivation of labor resources, the level of labor safety, the level of saturation of the organization with specialists, the personnel composition, represented by the age level of employees and the level of professional development. As a result, to determine the main gaps in personnel security of an energy enterprise, which subsequently affects the creation of a high level of economic security in the aspect of sustainable development of such a business entity.

In this research, let's focus on the personnel security of the enterprise, which is an integral part of the formation and strengthening of the economic security of the enterprise in the conditions of its continuous sustainable development. *The object of research* is the personnel security of the enterprise. *The aim of research* is to analyze the possible components of personnel security of an enterprise and highlight their greatest impact, using the

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tools of the fuzzy set method. It is the use of this method that is a new way of processing a data array to obtain results and conclusions. The uniqueness of this approach lies in the fact that the fuzzy set method has not been used previously in managing all components of economic security, including personnel factors. This makes it possible to expand the framework of the economic security system in the methodology of risk management theory (as in the classical view it is being studied at the moment) and to present in more detail the existing problem areas in personnel security of energy enterprises. To achieve the goal, let's consider the components of the company's personnel security, determine the optimal tools for analyzing data indicators and evaluate the obtained indicators in the company's practice.

2. Materials and Methods

Within the framework of this study, let's use the methods of analysis, synthesis and fuzzy sets. The components of personnel security were identified, their sequence and influence on the overall economic security of the enterprise in the conditions of its modern development were outlined.

The use of the fuzzy set method made it possible to analytically create a linguistic variable with the entire possible set of values, which constructively describes the level of danger of working with a value from zero to one. The use of statistical analysis methods made it possible to obtain results for six components of personnel security and calculate the final result over the years over time, which directly made it possible to draw conclusions about existing gaps in the company under study.

By the way, the choice of the company to conduct the analysis and present the accuracy, practicality and objectivity of the results obtained was made in favor of Joint Stock Company "National Nuclear Energy Generating Company "Energoatom" (JSC NNEGC Energoatom, Kyiv, Ukraine). This is an enterprise in the energy industry, the full block of shares of which belongs to the state. The company is engaged in the production of electrical energy using the nuclear industry. We were interested in this legal entity due to the fact that 55.2 % of the country's total energy is produced by them. On the one hand, this indicates the presence of a monopoly, but the fact that the critical infrastructure object is state-owned indicates that this action is legal and ensures the well-being of its population. It should also be noted that the events after February 24, 2022 are decisive for Ukraine, and monitoring various kinds of changes that entail economic security is extremely important now, as well as during the period of the country's recovery.

The application of the comparison method allowed to analyze the changes in the results of the components of personnel security in the period from 2018 to 2022 for the studied enterprise. The data obtained indicated the unevenness and lack of sustainable development of the enterprise in terms of improving the quality of education and improving the qualification level of its employees.

In the future, using the method of generalization, it turned out to be possible to coordinate the directions of the company's development with an emphasis on the obtained results and shortcomings. Using the method of abstract logical analysis, it is proposed to strengthen economic security by attracting young workers, constantly improving their qualifications and forming a collective culture of the enterprise.

Currently, there is a wide variety of methods that allow analyzing labor resources and their condition, including methods of deterministic factor analysis. But their significant drawback is the inability to determine the level of sufficiency of certain characteristics. As a result, the data obtained of this kind prevents a more objective description of the level of economic security of the enterprise. However, the analyst must have a clear understanding of what is "good" or "bad" about an organization relative to the industry to which it belongs. In addition, in modern conditions, in order to increase the efficiency of an organization, it is relevant to formalize all processes occurring in it, including the process of analyzing personnel security. A solution to this problem can be found using the fuzzy set method, which has recently found frequent use in various studies, including economic ones.

Fuzzy descriptions in the structure of the method of economic analysis appear due to the analyst's uncertainty, which arises in the course of various types of classifications. For example, when an analyst cannot clearly distinguish between the concepts of "high" and "maximum" probability, or when it is necessary to draw a line between the average and low level of a parameter value. Then the use of fuzzy descriptions allows to perform the following operations:

– the analyst constructs a linguistic variable with its entire possible set of values, for example, the variable "work hazard", which can have a term set of values "very low", "low", "medium", "high", "very high";

– in order to constructively describe a linguistic variable, the analyst selects a quantitative attribute corresponding to it – for example, a specially selected indicator of the level of danger of work, which takes values from zero to one.

Next, the analyst associates each value of the linguistic variable (which, by its construction, is a fuzzy subset of the values of the interval (0, 1) of the range of values of the indicator of the level of danger of work) with a membership function of the level of danger with one or another fuzzy subset. In this case, trapezoidal membership functions should be used.

Graphically, the membership functions $\mu_j(ks)$ can be observed in Fig. 1.

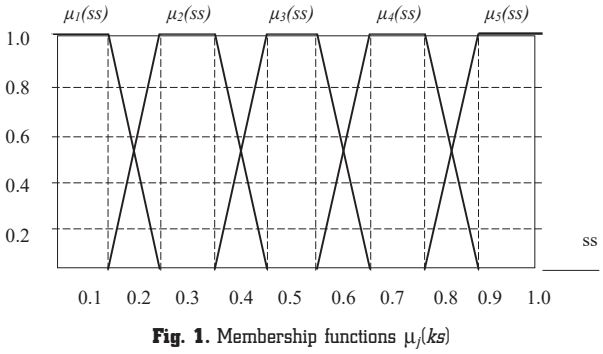

Fig. 1. Membership functions $\mu_j(ks)$

Based on the above, a classification of the current value *ks* of the personnel security level indicator will be constructed as a criterion for dividing this set into fuzzy subsets (Table 1).

A set of individual rs_i indicators with a total number of 6 is taken as indicators characterizing the level of personnel security.

Table 1

Classification of the level of personnel security

Range of values *ks*	Parameter level classification	Degree of estimated confidence (membership function $\mu_j(ks)$)
$0 \le k_s \le 0.15$	KS_1 "Insignificant level of personnel security"	$\mu_1(ks) = 1$
$0.15 \le k_s \le 0.25$	KS_1 "Insignificant level of personnel security"	$\mu_1(ks) = 10 \cdot (0.25 - ss)$
	KS_2 "Low level of personnel security"	$\mu_2(ks) = 1 - \mu_1(ss)$
$0.25 \le k_s \le 0.35$	KS_2 "Low level of personnel security"	$\mu_2(ks) = 1$
$0.35 \le k_s \le 0.45$	KS_2 "Low level of personnel security"	$\mu_2(ks) = 10 \cdot (0.45 - ss)$
	KS_3 "Average level of personnel security"	$\mu_3(ks) = 1 - \mu_2(ss)$
$0.45 \le k_s \le 0.55$	KS_3 "Average level of personnel security"	$\mu_3(ks) = 1$
$0.55 \le k_s \le 0.65$	KS_3 "Average level of personnel security"	$\mu_3(ks) = 10 \cdot (0.65 - ss)$
	KS_4 "High level of personnel security"	$\mu_4(ks) = 1 - \mu_3(ss)$
$0.65 \le k_s \le 0.75$	KS_4 "High level of personnel security"	$\mu_4(ks) = 1$
$0.75 \le k_s \le 0.85$	KS_4 "High level of personnel security"	$\mu_4(ks) = 10 \cdot (0.85 - ss)$
	KS_5 "Maximum level of personnel security"	$\mu_5(ks) = 1 - \mu_4(ss)$
$0.85 \le k_s \le 1.0$	KS_5 "Maximum level of personnel security"	$\mu_5(ks) = 1$

For each individual indicator rs_i, a linguistic variable $B_{i.j}$ "Level of indicator ks_i" is set, consisting of five term sets:

$B_{i.1}$ – subset "Very low level of indicator";

$B_{i.2}$ – subset "Low level of indicator";

$B_{i.3}$ – subset "Average level of indicator";

$Bi_{.4}$ – subset "High level of indicator";

$B_{i.5}$ – subset "Very high level of indicator".

The carrier of the set $B_{i.j}$ – "Indicator level k_{si}" – bi for each indicator takes values within the limits determined by the expert.

A qualitative assessment of the influence of indicators k_{si} on the level of personnel security is made using coefficients $\beta_{i.j}$, each of which corresponds to the j-term set of the linguistic variable $B_{i.j}$ and takes the following values: 0.075, 0.3, 0.5, 0.7, 0.975. The distribution of these values is selected by the analyst independently for each indicator separately, depending on which values of the indicators according to k_{si} are the best (maximum, minimum, average).

3. Results and Discussions

According to the above methodology, six indicators of the linguistic variable – k_{si} – are determined for each analyzed year.

Indicator k_{s1} – average salary, as an element of motivation. A rational policy of personnel motivation is quite competitive compared to other enterprises, ensures its consistency and has a positive impact on the economic security of the organization.

After studying the annual reviews of the work of JSC NNEGC Energoatom for each analyzed year, Table 2 presents the values of the average salary, the coefficient k and the derived indicators k_{s1} for each year under consideration, normalized to the base year (2022).

Each of the indicators, depending on its value, must be assigned to one of the fuzzy subsets B_{1j}, determining the values of the membership functions $\mu_j(k_{s1})$. The result is presented in dynamics in Table 3.

One of the components of personnel security is the level of worker safety and harm to its health. In this regard, it is important to analyze and determine the level of influence of this component.

The indicator k_{s2} is subject to analysis – the injury frequency rate, reflecting labor safety per 1 kW/h of finished product.

As a result of studying statistical data for five years and operational results of JSC NNEGC Energoatom, Table 4 presents the calculated values of k_{s2}.

Each of the indicators k_{s2}, depending on its value, belongs to one of the fuzzy subsets B_{2j}, thereby determining the values of the membership functions $\mu_j(ks_2)$. The results of the studies carried out according to the methodology are presented dynamically in Table 5.

The level of economic security depends on how quickly and effectively its management and specialists can prevent possible threats and promptly eliminate the harmful consequences of certain negative components of the external and internal environment.

Table 2

k_{s1} indicators

Years	Average salary, UAH (USD*)	k coefficient	Indicator k_{s1} normalized to the base year, UAH (USD*)
2018	23.300 (856.60)	1.311	30.546 (1122.99)
2019	30.382 (1175.51)	1.205	41.452 (1603.83)
2020	36.522 (1354.67)	1.135	43.772 (1623.59)
2021	41.100 (1506.04)	1.065	43.772 (1603.95)
2022	46.032 (1432.37)	1.000	46.032 (1423.37)

Note: * calculated at the average exchange rate of the National Bank of Ukraine in the relevant year

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Table 3

Levels of membership of the carrier k_{s1} to the fuzzy subsets B_{1j}

Values of the k_{s1} indicator	Value of $\mu_j(k_{s1})$ in period n for each subset B_{1j}					Indicator significance level
	B_{11} – "Very low level of k_{s1} indicator"	B_{12} – "Low level of k_{s1} indicator"	B_{13} – "Average level of indicator k_{s1}"	B_{14} – "High level of k_{s1} indicator"	B_{15} – "Very high level of k_{s1} indicator"	
2018	0	0.51	0.49	0	0	$r_1^{ss} = 0.286$
2019	0	0	1	0	0	
2020	0	0	1	0	0	
2021	0	0	0.78	0.22	0	
2022	0	0	0.48	0.52	0	
β_{1i}	$\beta_{12} = 0.075$	$\beta_{13} = 0.300$	$\beta_{14} = 0.500$	$\beta_{15} = 0.700$	$\beta_{16} = 0.975$	

Table 4

k_{s2} indicators

Indicators	2018	2019	2020	2021	2022
Product output, thousand kW/h	16150	16800	18730	18710	20150
Number of accidents at work	0	2	0	0	0
K_{S2} – injury frequency rate per 1 thousand kW/h of finished products	0	0.29	0	0	0

Table 5

Levels of membership of the carrier k_{s2} to the fuzzy subsets B_{2j}

Values of the k_{s2} indicator	Value of $\mu_j(k_{s2})$ in period n for each subset B_{2j}					Indicator significance level
	B_{21} – "Very low level of k_{S2} indicator"	B_{22} – "Low level of k_{S2} indicator"	B_{23} – "Average level of indicator k_{S2}"	B_{24} – "High level of k_{S2} indicator"	B_{25} – "Very high level of k_{S2} indicator"	
2018	1	0	0	0	0	$r_2^{ss} = 0.238$
2019	0	1	0	0	0	
2020	1	0	0	0	0	
2021	1	0	0	0	0	
2022	1	0	0	0	0	
β_{2i}	$\beta_{22} = 0.975$	$\beta_{23} = 0.700$	$\beta_{24} = 0.500$	$\beta_{25} = 0.300$	$\beta_{26} = 0.075$	

In this regard, one of the indicators characterizing the labor safety of an organization, and therefore its effectiveness, is the k_{S3} indicator – the level of saturation with specialists, the result of which is calculated over time in Table 6.

Each of the indicators k_{S3}, depending on its value, belongs to one of the fuzzy subsets B_{3j}, thereby determining the values of the membership functions $\mu_j(k_{s3})$. The dynamic result is presented in Table 7.

The level of professional training of employees in the organization has an important impact on the level of personnel security, and, consequently, on economic security. Therefore, it is advisable to determine the level of professional training of enterprise personnel. The result of the calculation and analysis of the k_{S4} indicator – the level of professional training of workers is given in Table 8.

Each of the indicators k_{S4}, depending on its value, belongs to one of the fuzzy subsets B_{4j}, thereby determining the values of the membership functions $\mu_j(k_{s4})$. The dynamic result is presented in Table 9.

As studies have shown, the level of labor safety is influenced by the age composition of workers.

For this purpose, it is necessary to determine the average age of the employees of the analyzed organization and the level of its influence on the safety of the organization. The results of calculating the indicator k_{S5} – the average age of the enterprise's employees is shown in Table 10.

Each of the found indicators, depending on its value, belongs to one of the fuzzy subsets B_{5j}, determining the values of the membership functions $\mu_j(k_{S5})$. The dynamic result is presented in Table 11.

The introduction of scientific and technological progress and best practices into production is currently impossible without the participation of young specialists, as carriers of new knowledge and as one of the components of personnel security. Therefore, it is important to consider the impact of the level of young specialists on the personnel security of the enterprise.

The k_{S6} indicator (proportion of young specialists) is given in Table 12.

Each of the found indicators k_{S6}, depending on its value, should also be assigned to one of the fuzzy subsets B_{6j}, having determined the values of the membership functions $\mu_j(k_{S6})$. The dynamic result is presented in Table 13.

Next, a comprehensive indicator of personnel security k_s is determined for each year separately. In order to reduce several individual indicators into one, according to the fuzzy sets technique, double convolution is carried out, based on the data given in Tables 3, 5, 7, 9, 11, 13. As a result, the following indicators of personnel security are obtained by year of the analyzed organization.

Table 6

k_{S3} indicators

Indicators	2018	2019	2020	2021	2022
Average annual number of specialists, people	302	307	309	305	308
Number of production workers, people	1803	1949	1914	1988	2074
k_{S3} – level of saturation with specialists	0.17	0.16	0.16	0.15	0.15

Table 7

Levels of membership of the carrier k_{S3} to the fuzzy subsets B_{3j}

Values of the k_{s3} indicator	Value of $\mu_j(k_{S3})$ in period n for each subset B_{3j}					Indicator significance level
	B_{31} – "Very low level of k_{s2} indicator"	B_{32} – "Low level of k_{S3} indicator"	B_{33} – "Average level of indicator k_{S3}"	B_{34} – "High level of k_{S3} indicator"	B_{35} – "Very high level of k_{S3} indicator"	
2018	0.8	0.2	0	0	0	$r_3^{ss} = 0.191$
2019	0.9	0.2	0	0	0	
2020	0.9	0.2	0	0	0	
2021	1	0	0	0	0	
2022	1	0	0	0	0	
β_{3i}	$\beta_{32}=0.500$	$\beta_{33}=0.975$	$\beta_{34}=0.700$	$\beta_{35}=0.300$	$\beta_{36}=0.075$	

Table 8

k_{S4} indicators

Indicators	2018	2019	2020	2021	2022
Number of production workers trained in production, people	921	455	834	694	745
Number of employees who have improved their qualifications, people	1107	1630	947	968	802
Number of production workers, people	1803	1949	1914	1988	2074
K_{S4} – level of saturation with specialists	0.12	0.12	0.28	0.22	0.23

Table 9

Levels of membership of the carrier k_{s4} to the fuzzy subsets B_{4j}

Values of the k_{s4} indicator	Value of $\mu_j(k_{s4})$ in period n for each subset B_{4j}					Indicator significance level
	B_{41} – "Very low level of k_{S4} indicator"	B_{42} – "Low level of k_{S4} indicator"	B_{43} – "Average level of indicator k_{S4}"	B_{44} – "High level of k_{S4} indicator"	B_{45} – "Very high level of k_{S4} indicator"	
2018	0	0	1	0	0	$r_4^{ss} = 0.095$
2019	0	0	1	0	0	
2020	0	0	0	0	1	
2021	0	0	0	0.667	0.333	
2022	0	0	0	0.333	0.667	
β_{4i}	$\beta_{42}=0.075$	$\beta_{43}=0.300$	$\beta_{44}=0.700$	$\beta_{45}=0.975$	$\beta_{46}=0.500$	

Table 10

k_{S5} indicators

Indicators	2018	2019	2020	2021	2022
Under 20 years old	35	38	43	49	29
20–30 years	695	874	973	1019	986
31–40 years old	952	942	1002	1106	1233
41–50 years old	985	924	971	988	1027
51–60 years	828	869	824	960	992
Over 60 years	103	118	120	139	157
Average headcount, people	3598	3765	3933	4261	4424
K_{S5} – average age of employees, years	41.6	41.0	40.4	40.7	41.1

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Table 11

Levels of membership of the carrier k_{s5} to the fuzzy subsets B_{5j}

Values of the k_{55} indicator	Value of $\mu_j(k_{55})$ in period n for each subset B_{5j}					Indicator significance level
	B_{51} – "Very low level of k_{55} indicator"	B_{52} – "Low level of k_{55} indicator"	B_{53} – "Average level of indicator k_{55}"	B_{54} – "High level of k_{55} indicator"	B_{55} – "Very high level of k_{55} indicator"	
2018	0	0	0.49	0.51	0	$r_5^{ss} = 0.095$
2019	0	0	0.55	0.45	0	
2020	0	0	0.6	0.4	0	
2021	0	0	0.57	0.43	0	
2022	0	0	0.54	0.46	0	
β_{5i}	$\beta_{52}=0.075$	$\beta_{53}=0.500$	$\beta_{54}=0.975$	$\beta_{55}=0.700$	$\beta_{56}=0.300$	

Table 12

k_{56} indicators

Indicators	2018	2019	2020	2021	2022
Number of young specialists at the enterprise, people	427	612	631	603	622
Average headcount, people.	3598	3765	3933	4261	4424
k_{56} – share of young specialists, %	11.8	16.3	16.0	14.2	14.1

Table 13

Levels of membership of the carrier k_{s6} to the fuzzy subsets B_{6j}

Values of the k_{56} indicator	Value of $\mu_j(k_{s6})$ in period n for each subset B_{6j}					Indicator significance level
	B_{61} – "Very low level of k_{56} indicator"	B_{62} – "Low level of k_{56} indicator"	B_{63} – "Average level of indicator k_{56}"	B_{64} – "High level of k_{56} indicator"	B_{65} – "Very high level of k_{56} indicator"	
2018	0.82	0.18	0	0	0	$r_6^{ss} = 0.095$
2019	0.37	0.63	0	0	0	
2020	0.4	0.6	0	0	0	
2021	0.58	0.42	0	0	0	
2022	0.59	0.41	0	0	0	
β_{6i}	$\beta_{62}=0.500$	$\beta_{63}=0.975$	$\beta_{64}=0.700$	$\beta_{65}=0.300$	$\beta_{56}=0.075$	

The comprehensive indicator of personnel security:
– at the end of 2018 is:

$$K_S = 0.3 \cdot 0.51 \cdot 0.286 + 0.9758 \cdot 1 \cdot 0.238 + 0.5 \cdot 0.8 \cdot 0 \cdot 0.191 + 0.7 \cdot 1 \cdot 0.095 + 0.7 \cdot 0.51 \cdot 0.095 + 0.5 \cdot 0.82 \cdot 0.095 = 0.49; \quad (1)$$

– at the end of 2019 is:

$$K_S = 0.51 \cdot 1 \cdot 0.286 + 0.7 \cdot 1 \cdot 0.238 + 0.5 \cdot 0.9 \cdot 0.191 + 0.7 \cdot 1 \cdot 0.095 + 0.7 \cdot 0.51 \cdot 0.095 + 0.975 \cdot 0.63 \cdot 0.095 = 0.057; \quad (2)$$

– at the end of 2020 is:

$$K_S = 0.5 \cdot 1 \cdot 0.286 + 0.975 \cdot 1 \cdot 0.238 + 0.5 \cdot 0.9 \cdot 0.191 + 0.5 \cdot 1 \cdot 0.095 + 0.975 \cdot 0.6 \cdot 0.095 + 0.975 \cdot 0.6 \cdot 0.095 = 0.62; \quad (3)$$

– at the end of 2021 is:

$$K_S = 0.5 \cdot 0.78 \cdot 0.286 + 0.975 \cdot 1 \cdot 0.238 + 0.5 \cdot 1 \cdot 0.191 + 0.975 \cdot 0.667 \cdot 0.095 + 0.975 \cdot 0.57 \cdot 0.095 + 0.5 \cdot 0.58 \cdot 0.095 = 0.58; \quad (4)$$

– at the end of 2022 is:

$$K_S = 0.7 \cdot 0.52 \cdot 0.286 + 0.975 \cdot 1 \cdot 0.238 + 0.5 \cdot 1 \cdot 0.191 + 0.6 \cdot 0.667 \cdot 0.095 + 0.975 \cdot 0.54 \cdot 0.095 + 0.5 \cdot 0.59 \cdot 0.095 = 0.54. \quad (5)$$

Then the values of personnel security indicators k_S obtained by year of the analyzed period are classified. The result of the classification will be: a linguistic description of the personnel security indicator, by which one can judge the degree of confidence of the expert analyst in the correctness of its classification – $\mu_j(k_S)$. The obtained data are presented in Table 14.

The article [35] considers economic security as a sustainable development of business entities. According to the authors, it is not possible to make profits in the future without ensuring a solid state of affairs at the moment. But the authors consider further development as stable and continuous and completely exclude positions of uncertainty and remoteness of the information space for forecasting. In our opinion, in such a case, it will not be correct to determine further development paths based only on risks. Let's believe that this position is based on the classical concept and use of risk management tools. By contrast, our position addresses broader aspects of uncertainty in the future.

Table 14

Summary table of personnel security indicators for the years under study

Years	Personnel security indicator k_s	Linguistic description of k_s	Membership function $\mu_j(k_S)$
2018	0.49	KS_3 "Average level of personnel security"	$\mu_j(k_S)=1.0$
2019	0.57	KS_3 "Average level of personnel security"	$\mu_j(k_S)=0.8$
2020	0.62	KS_4 "High level of personnel security"	$\mu_j(k_S)=0.7$
2021	0.58	KS_3 "Average level of personnel security"	$\mu_j(k_S)=0.7$
2022	0.54	KS_3 "Average level of personnel security"	$\mu_j(k_S)=1.0$

The authors of [36, 37] suggest projecting future change and development based on data obtained in the present enterprise. Such an opinion is balanced and reliable, but the question remains open to what extent the information, statistical data and results of the financial activity of the enterprise are reliable, and the person who analyzes and accumulates them is objective in its opinions. In this position, we are interested in the human factor and the ability to interpret the data obtained in different ways. Therefore, in our work let's use five subfactors, dividing the set into subsets in personnel security coefficients. That is, in this case it is worth turning to set theory and again uncertainty. In our opinion, combining these approaches with our previous work would be a guarantee of obtaining good results. In this vein, it is also worth noting the development in the methodology of set theory belonging to [38], which adheres to development based on inflationary processes. In this case, there is a direct connection with the personnel of the enterprise and the level of wages. But this theory has only an indirect influence and refers to the sub-contextual direction, instead [39, 40] investigate personnel problems of their countries (China and Romania, respectively) in energy companies. In the opinion of these authors, the theory of forecasts and uncertainty, the Monte-Cralo and VAR methods are inferior in effectiveness to the method of fuzzy sets, which is considered by us in this work. In this case, the calculation due to the average error is more reliable than the construction of fan diagrams. But it is worth noting that in the course of our research we chose for analysis the years before the military invasion and during it. This significantly affected the results obtained in a negative way and has consequences precisely in the context of the topic of the study – the personnel composition of the enterprise. In this case, it is worth paying attention to the further course of events in the field of energy and directing scientific achievements to improve the economic security of critical infrastructure enterprises.

As a result of the study, six components of personnel security of the enterprise were proposed, which are elements of a larger system of improvement and development such as economic security. According to the proposed criteria, using the theory of fuzzy sets, an approach for calculating sub criteria is presented, which makes it possible to increase the objectivity of the data and express their different nature in one dimension, that is, to unify them. It is possible to assume that this approach may become more applicable to other industries in the future. For example, those that provide livelihoods to the population (environmental protection, healthcare, education), improve the quality of life (municipal authorities, government and law), as well as sectors of the economy (trade, import, export, production and others).

According to the results of the analysis of the personnel policy of JSC NAEK Energoatam, since 2018, a decrease in the level of personnel security (k_S) has been observed. The reason for the decrease in the organization's personnel supply was the decrease in the level of specialists in the general workforce, especially young specialists, as shown in the calculation results presented above. This was facilitated by the mismatch between the average level of wages of employees and the market value of such services. In the calculations, average indicators for the enterprise were used, but it is worth emphasizing that young specialists will receive the lowest value in the average calculation scale. In this case, their motivation and interest in choosing this field gradually decreases. And since February 2022, the situation has worsened due to military aggression against the country.

In this regard, let's recommend JSC NNEGC Energoatom to increase the level of young specialists or to increase the level of the average annual number of specialists by 30 % as a whole, which will allow to increase k_{S6} indicators (the share of young specialists) to the optimal level necessary to ensure personnel safety. Also, according to this indicator, the recommendation could be an increase in wages for young specialists, their training as part of the promotion of the career ladder in the company and remuneration in connection with work in the critical infrastructure industry. That is, to assume that the intensity of work and intellectual abilities of employees at the management level can be rewarded more than they currently are. This will add motivation to employees and thus improve the indicators of personnel safety factors.

As can be seen from the above, in the organization under study, the dynamics of improving the qualifications of employees is deteriorating. This implies the need to increase the number of employees who have undergone advanced training. In general, the proposed measures will allow JSC NNEGC Energoatom to increase the level of staffing to a value of 0.65, which corresponds with a high level to the "average level of staffing".

Also within the framework of this study, it is worth paying attention to the martial law that has been going on in the country for almost 3 years. Given the object of analysis, it is worth noting that such indicators as the general reduction of the company's employees, their motivation, deterioration of qualifications and the number of young people have been negatively affected in recent years. After 2022, the negative dynamics will be observed even more clearly. Therefore, let's consider it appropriate to draw attention to the use of modern methods of personnel management in future studies. These include the optimization of work processes using artificial intelligence, the use of assistants in a cloud environment, the unification of documents using servers and the implementation of informal training processes to improve the skills of personnel.

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It is worth paying attention to possible limitations regarding the proposed methodology for applying fuzzy sets when determining the level of economic security of an enterprise through labor resource management. In our opinion, this approach is quite unified, therefore it can be applied in different industries. But there is an essential circumstance regarding the calculations - the data to be analyzed must correspond to reality. In this case, if to talk about labor resources, it is necessary to clearly approach the issues of motivation (demotivation) of personnel, characteristics of the workplace and satisfaction with working conditions, as well as safety (especially for areas of increased danger). In this case, for further scientific and practical application, let's consider it appropriate to recommend conducting surveys, including cross-sectional questions, tracking results in dynamics among the same employees, forming a database of results using fuzzy spaces, using modeling of expert opinions and Euler circles to calculate data and obtain a subjective assessment. Accordingly, it is logical to apply the tools of mathematical modeling, statistical analysis, and uncertainty theory. This will further contribute to understanding the real limits and conditions of application of the proposed solutions.

Thus, it can be said that ensuring personnel security can be improved by conducting a more objective analysis of the state of labor resources based on the use of the fuzzy set method. In the future, this will help to use the results of the analysis for a qualitative assessment of planning and forecasting the activities of the enterprise. And as a result, due to the synergy effect, they will positively affect the process of strengthening the economic security of the enterprise. In the future, the development of this direction may find its application in the study of other components of economic security, such as financial stability, investment activity, planning and others, and the approach using fuzzy sets can open up new prospects for solving possible problems.

4. Conclusions

As a result of the research, results were obtained regarding the components of personnel security that directly affect the processes of strengthening economic security. The proposed analysis method was tested within the framework of the analysis of the activities of JSC "NNEGC "Energoatom". Data were received on the main indicators at the level of low value – indicator 0.49 (2018), average – 0.54 (2022), 0.57 (2019) and 0.58 (2021) and sufficient – 0.62 (2020). The tendency to decrease the generalized indicators after 2020 indicates an imbalance in the personnel policy of the enterprise, which has negative consequences. In recent years, the situation has worsened even more due to active military operations in Ukraine. And the problems identified in the work, such as low wages for young specialists, lack of training, advanced training, demotivation, in our opinion, encourage the results obtained. However, the analysis conducted using the fuzzy set method widely demonstrated weaknesses and unresolved issues for these enterprises. Accordingly, this is a weighty argument for making management decisions to strengthen the economic security of JSC "NNEGC "Energoatom". It is also considered as appropriate to recommend to other business entities of the unified energy system of Ukraine to implement the specified method for sustainable development of enterprises. In this case, it can be assumed that the performance indicators of each legal entity will increase, the levels of economic security to improve the overall situation in the energy market should correspond to sufficient (0.6–0.8) and high (0.8–1.0) levels. Accordingly, strengthening the economic security of the energy sector will shape the development of the country in accordance with the goals set out in the Development Strategy of Ukraine for the period until 2030, which is currently an extremely important factor in ensuring the livelihoods of the population.

Conflict of interest

The authors declares that they have no conflict of interest in relation to this study, including financial, personal, authorship or other, which could affect the study and its results presented in this article.

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Use of artificial intelligence

The authors confirm that they did not use artificial intelligence technologies when creating the presented work.

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Kateryna Andriushchenko, *Doctor of Economic Sciences, Professor, Department of Business Economics and Entrepreneurship, Kyiv National Economic University named after Vadym Hetman, Kyiv, Ukraine, ORCID: https://orcid.org/0000-0002-6274-5310*

Andrii Buriachenko, *Doctor of Economic Sciences, Professor, Department of Finance named after V. Fedosov, Kyiv National Economic University named after Vadym Hetman, Kyiv, Ukraine, ORCID: https://orcid.org/0000-0002-7354-7491*

✉***Anastasiia Liezina,*** *PhD, Associate Professor, Department of Business Economics and Entrepreneurship, Kyiv National Economic University named after Vadym Hetman, Kyiv, Ukraine, e-mail: lezya86@gmail.com, ORCID: https://orcid.org/0000-0003-0516-6598*

Oksana Lavruk, *PhD, Associate Professor, Department of Management, Kamianets-Podilskyi Ivan Ohiienko National University, Kamianets-Podilskyi, Ukraine, ORCID: https://orcid.org/0000-0001-9089-237X*

Nataliia Korzhenivska, *Doctor of Economic Sciences, Professor, Department of Economics, Business, Trade and Exchange Activities, Higher Educational Institution "Podillia State University", Kamianets-Podilskyi, Ukraine, ORCID: https://orcid.org/0000-0002-4665-6676*

Nataliia Slavina, *PhD, Associate Professor, Department of Management, Kamianets-Podilskyi Ivan Ohiienko National University, Kamianets-Podilskyi, Ukraine, ORCID: https://orcid.org/0000-0002-3761-9865*

✉ *Correspondent author*